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BEAVER HOUSE IN PROCESS OF CONSTRUCTION.

Considerable skill and energy are required by the beaver to climb in an upright position to the point where the load of building material carried is to be deposited.

UNITED STATES DEPARTMENT OF AGRICULTURE

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BEAVER HABITS, BEAVER CONTROL, AND POSSIBILITIES IN BEAVER FARMING.

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INTRODUCTION.

Only two centuries ago beavers inhabited the greater part of the North American Continent and were to the native people an important source of food and warm clothing. Their fur soon attracted the white traders and trappers, and traffic in their skins became an important factor in promoting the early settlement of the country. Through the generations of intensive trapping that followed, the beavers were greatly reduced in numbers and restricted in range until they have been exterminated over much of their area. For the last 20 years they have been given special protection in many sections of the country and after being long absent have been restored to some parts of their old range, where under favorable conditions they have thrived and increased rapidly.

As a great part of the original range of the beaver is now under cultivation, and fields and orchards replace the primeval forests, it is obviously unwise to restore the animals to all of their original waters, but there are still many localities where they could be introduced without harm, and where, by storing water in the reservoirs along mountain streams, they would do great good in helping prevent

NOTE.—This bulletin discusses methods of dealing with beavers when their operations conflict with agriculture and other human activities, methods of transporting them to localities where they may be conserved as a valuable and interesting natural resource, and methods of utilizing them as an important supplement to the fur supply by establishing them in suitable climates, particularly in certain waste lands and other areas unsuited to agriculture.

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floods and extensive erosion, in increasing the stream flow in dry weather, and in improving the fishing resources of streams and lakes. In such places they would not only enrich our forests and parks with a unique and intensely interesting form of wild life, but would also add much valuable fur to our decreasing supply.

Even in the mountains and remote wildernesses, however, there are many localities where beavers, if allowed unrestricted freedom, would surely destroy much valuable timber, ruin many of the most attractive lake and stream borders, destroy trails and roads, and even endanger railroad beds and human lives. While interesting, desirable, and valuable animals in their place, they must be controlled to a certain extent or they will become exceedingly troublesome and destructive.

Beavers at one time produced fur of greater value than that of any other fur-bearing animal of North America. During the period when the fur traders dominated a vast region in the West and North, the beaver skin was the unit of value used in the traffic between the Indians and the white trappers. Through unrestricted trapping beavers were exterminated over great areas and for a time threatened with complete extinction, but with the protection given them in recent years they are now returning to many parts of their former range.

The necessary control of beavers in any part of the country need not be difficult, but must be based on a thorough knowledge of the animals and their habits. Controlling them under semidomestic conditions, in beaver farming as a business enterprise, has not yet been satisfactorily tested, but with our present knowledge of the habits of beavers there is every reason to believe that this may develop into a successful industry.

DISTRIBUTION.

Beavers originally occupied the streams of most of the continent of North America from the mouths of the Rio Grande and Colorado Rivers and northern Florida north to Labrador, Alaska, and the mouth of the Mackenzie, well within the Arctic Circle (Fig. 1). Over this enormous area they are exposed to a great variety of climatic and environmental conditions, which have produced numerous geographic races, or subspecies. These vary somewhat in size and proportions, but far more in the color, quality, and value of the fur. Generally they are paler in the south and darker in the north, but the darkest, most beautiful, and most valuable fur is found along the southern shore of Lake Superior.

DESCRIPTION.

Beavers have been directly responsible, in the construction of dams, for holding water in storage, preventing erosion, and profoundly af-

fecting the topography of vast areas through an unknown period. Before considering the question of controlling these natural engineers or of utilizing them in beaver farming, it is important to consider their physical character and remarkable habits.

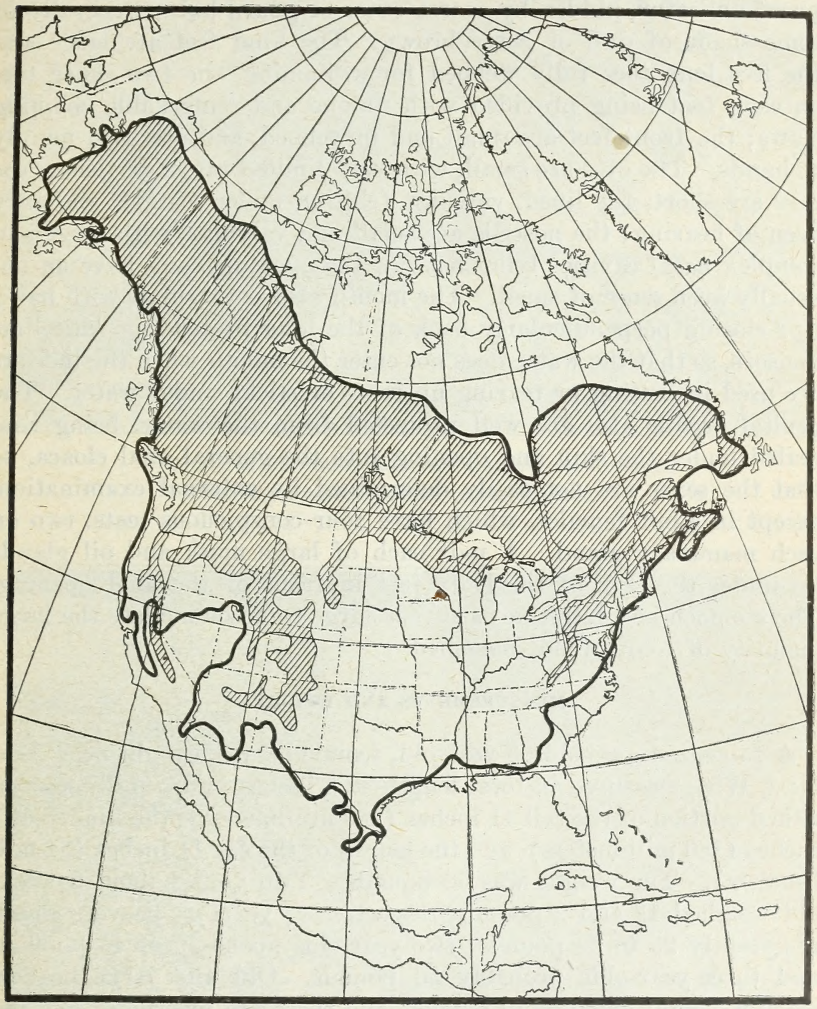

FIG. 1.—Range of beavers and their principal food tree, the aspen. The beaver was one of the most widely distributed mammals in North America, as shown by the heavy line bordering its original range. It now occupies about half of its original territory. The aspen or poplar (*Populus tremuloides* and varieties) is the most widely distributed tree in North America, as shown by the shaded area on the map, filling the Canadian and Hudsonian Zones and overlapping slightly into the upper edge of the Transition Zone. It marks the area of suitable climate for beaver farming and furnishes the best beaver food.

GENERAL PHYSICAL CHARACTERISTICS.

Beavers are compact, heavy-bodied, strongly framed animals (Pl. II, Fig. 1) with powerfully developed bones and muscular systems, broadly flattened naked tails, and dense coats of fine, soft, waterproof underfur, hidden by coarse outer or guard hairs, generally of some shade of dull or rusty brown. The hind feet are large and the five long toes fully webbed for swimming, the two inner toes on each foot being provided with unique and remarkable combing claws; the front feet are small and unwebbed, and are used mainly as hands. The eyes are small, with very limited range of vision; the ears are short, fur lined, valvular (closing under water), and very keen of hearing; the nostrils are small and valvular, with large and complex nasal cavities lying back of the openings, and have an unusually keen sense of smell. The mouth also is valvular, with hairy lips closing perpendicularly back of the long protruding, chisellike incisors, so that the water does not enter the mouth when the incisors are used in cutting or tearing up roots or sticks under water. The genital organs also are well protected from the water, being concealed under the skin and opening into the general anal cloaca, so that the sexes are not easily determined by external examination, except in adult females, which have four conspicuous teats, two on each mammary gland. A pair each of large musk and oil glands lie under the skin of the belly just in front of the anal opening. The stomach and intestines are very large to accommodate the large quantity of coarse food consumed.

MEASUREMENTS AND WEIGHT.

A fair-sized, probably 3-year-old, female beaver, caught near Ashland, Wis., measured in total length 42.5 inches (1,080 millimeters), naked portion of the tail 11 inches (280 millimeters), the hind foot 7 inches (180 millimeters), and the length of the ear $1\frac{1}{4}$ inches (34 millimeters). The weight was 50 pounds. Two young about 2 weeks old weighed $1\frac{3}{4}$ and 2 pounds, respectively; yearling beavers weigh apparently 25 to 30 pounds; two-year-olds about 40 or 45 pounds; and three-year-olds probably 50 pounds. Old and large beavers reach a weight of 60 to 70 pounds, and there are records of old and very fat beavers weighing from 100 to 110 pounds.

INTELLIGENCE.

Beavers are widely famed woodcutters and builders, and while not endowed with the degree of human intelligence often ascribed to them, they are wonderfully expert along their own lines and quick to learn and apply new methods or to take warning from new

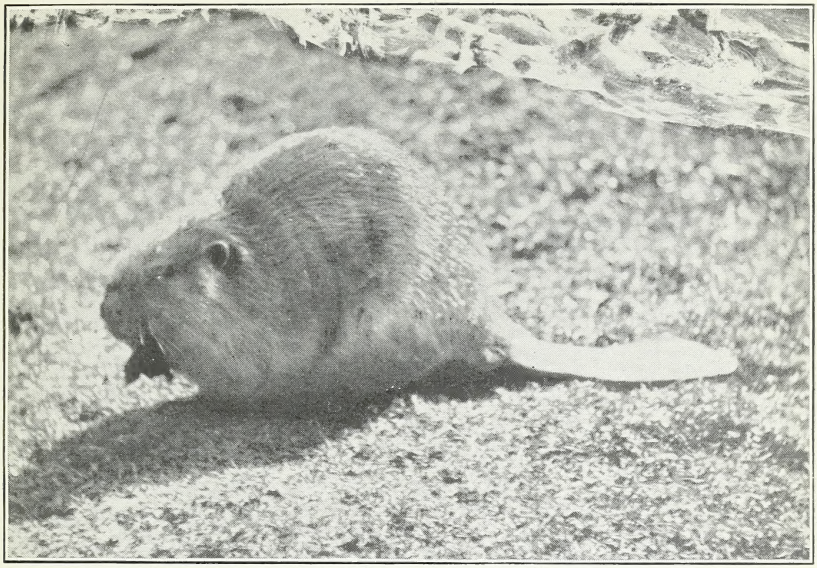

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FIG. 1.—A 35-POUND BEAVER CAUGHT IN PITFALL.

This animal was comparatively gentle from the first.

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FIG. 2.—YELLOW POPLARS CUT BY BEAVERS.

These trees, 12 inches in diameter, were cut at Brandreth Lake, N. Y. While aspens are the principal food trees of beavers, no distinction is made in varieties. The yellow poplar and even cottonwoods are eagerly accepted.

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FIG. 1.—YELLOW BIRCH, 14 INCHES IN DIAMETER, CUT BY BEAVERS.

The branches of birches are used for food and building material if aspens are not to be had.

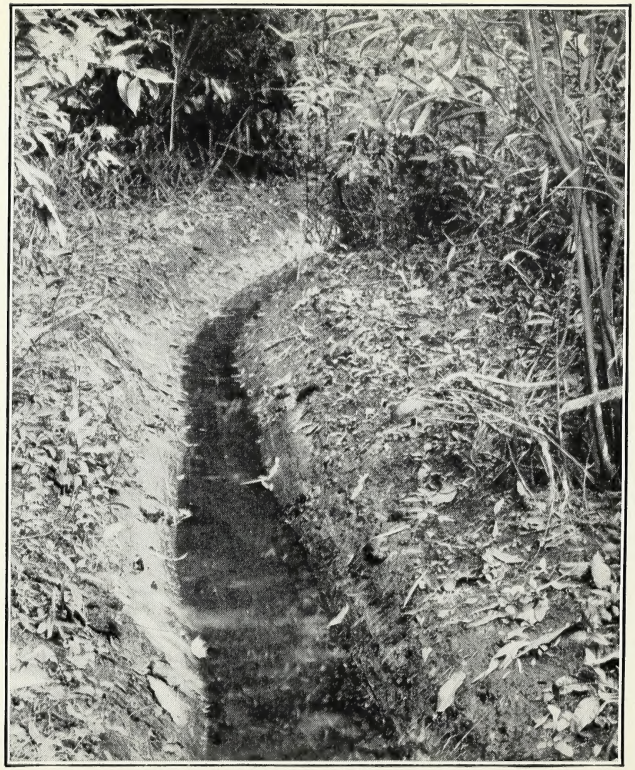

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FIG. 2.—BEAVER CANAL.

This canal leads from the pond to the source of food supply and is used for floating wood to the dam and house. (Photograph by T. H. Scheffer.)

dangers. Patience, persistence, strength, and industry are more important factors in their work than quick wit or versatility.

DISPOSITION.

Among themselves beavers are generally friendly and sociable, at least in their own family and colony. The young are especially playful and affectionate with each other and with anyone so fortunate as to win their confidence. Strangers, whether beaver or human, are likely to be treated as enemies, and a strange beaver placed in an inclosure with others is sometimes attacked and even killed. The common belief that the young when 2 years old are driven away from the colony is quite likely without foundation. The dispersal of a colony is probably due to a decrease in the easily accessible food supply.

HABITS.

SWIMMING.

Both the form and the anatomy of beavers show the adaptation of the animals to life in the water rather than on land. They are powerful, easy, and graceful swimmers, though ordinarily not rapid, merely paddling along with the large webbed hind feet; but when alarmed they can swim under water at great speed, apparently as fast as an otter or seal and with a somewhat similar undulatory motion of body and tail, the tail appearing to be effective as a high-speed propeller.

The question, Why is a beaver's tail flat and wide? is often asked, but it is only necessary to see it in use, tilted up, steering one way or the other, or striking downward as the animal dives from the surface, to understand its aquatic use. Especially is its full width and steering power taxed to its limit as the beaver swims, tuglike, by the side of a pole or log which it is towing to the house, dam, or food cache, with only the tail thrown out sideways to keep from progressing in circles. On land the tail has other uses, but in the water it serves variously as rudder, propeller, and signal gun, by giving loud slaps on the surface of the water for warnings to friends or enemies.

In diving, beavers simply swim downward or in any direction under water. They swim long distances and remain submerged commonly for four or five minutes at a time, but much longer if alarmed, swimming half a mile or more without appearing at the surface. In winter, under heavy ice and mainly under water, they move about from the house or bank den to the food cache or feeding grounds on the bottoms or banks of the ponds or streams, getting air from the bubbles under the ice, from air-filled chambers, or through air holes kept open to the surface.

WALKING.

On land the beavers walk with a slow, heavy, shuffling gait, the tail dragging on the ground or being held slightly above and swaying from side to side. At times one will gallop along fast enough to keep up with a person at a slow walk, but the young soon get tired and out of breath. If frightened, they will make a rush for cover or for the water, but at their best speed even an adult can be easily outrun by a person. They seem to realize their limitations on land, and rarely are their cuttings or any signs of them seen more than a few rods from the water. Trees have been found cut as far back as 10 or 12 rods from the shore, but track, trail, or trace of beavers is rarely if ever found farther from water.

TREE CUTTING.

In cutting trees each beaver works independently, although several sometimes have worked on the same tree. A small tree is generally cut through from one side, but a larger tree is usually cut on two sides or all around. The chips are cut above and below and split out much as by a woodman's ax, and a large pile usually surrounds the base of a recently cut stump. The tree falls the way it happens to lean, but along the shore most trees lean toward the water. The bark is generally eaten from the chips as they are cut out of trees, poles, or branches before the chips are dropped on the ground. One old beaver will fell a poplar tree 3 or 4 inches in diameter, cut it into sections of 4 to 8 feet each, and drag it to the water in one night. A larger tree will often withstand the attacks of several nights and when down will provide work for the whole family or colony for a week or more in cutting, trimming, and carrying the sections of branches and upper trunk to the water. Trunks over 5 inches in diameter are rarely cut up or moved from where they fall, unless lying in the water or very near by. Trees a foot in diameter are often cut down, and occasionally trees as large as 1½ or 2 feet in diameter. The largest I have even seen cut was a balsam poplar in Montana, 46 inches across the stump.[1]

Tree cutting for food.—Poplars (Pl. II, Fig. 2) and cottonwoods, all species of the genus *Populus*, are the favorite food of beavers, and few other trees are cut where these are to be had. Willows, birches (Pl. III, Fig. 1), pin cherry, alders, and the bush maples[2] come next. Many small bushes, hazel, witchhopple, cornel, service berry, and raspberry are cut for food, and under stress of necessity such hardwoods as birch, maple, ash, cherry, and even oak are felled both for food and

[1] Photograph published in Wild Animals of Glacier National Park, National Park Service, U. S. Dept. Interior, p. 66, 1918.

[2] *Acer pennsylvanicum* and *A. spicatum*.

for building material. Such conifers as hemlock, spruce, balsam, and tamarack are rarely cut, and then only for building purposes, not for food. Pines are practically immune from the attack of beavers, although I have seen a photograph of one yellow pine that had been cut down by them.

DIGGING.

Beavers do a great deal of digging, mainly under water. Their ponds are usually considerably deepened by the removal of mud and earth dug up from the bottom and added to the dams and houses. Large burrows begun at the bottom of their ponds, lakes, or streams lead obliquely back into the banks and end in nest cavities above the water level, entered only from under water. These bank burrows are sometimes 40 or 50 feet long and large enough for a man to crawl into.

Extensive canals, or waterways, for floating timber and for swimming through marshes or lowland to a food supply are dug and kept open while in use. These are often 2 feet wide and 1 or 2 feet deep, while old, long-used canals are even deeper and wider. (Pl. III, Fig. 2.) Beavers rarely dig on the surface of the ground and never make a burrow with an exposed entrance; only under stress of confinement or alarm will they even scratch at the bottom of a wire fence when inclosed. I have kept an old one for three days on a lawn under an inverted box and have had good-sized young for a month at a time in a wire-fence inclosure with the bottom wire resting on the surface of the ground.

TRANSPORTING MATERIALS.

The carrying done by the beavers is one of the most surprising parts of their remarkable work. In transporting wood on land they grasp or hold it with their strong incisor teeth, and with heads turned to one side drag heavy poles or good-sized branches. A stick or small branch is carried in the mouth clear of the ground or partly carried and partly dragged. In the water a pole or small log is usually towed by the side, the teeth being fastened into the bark near the front end. At other times the log is grasped by the arms and front claws, while the beaver swims powerfully at the side and steers with his broad tail.

In carrying stones, of which the dams are sometimes largely built, the hands and arms are used, but as the stones are brought up from the bottom of the pond and carried under water the water displaced serves to reduce the weight actually lifted. Stones 5 or 6 inches in diameter are commonly used.

In carrying mud and small sticks from the bottom of the pond to be placed on the dam or house the beaver does not use its tail, but its

hands and arms. One will come up from the water carrying a huge armful, held tightly against its breast, and, rising on its strong hind legs, balanced by the tail pressed on the ground behind it, walk in an upright position to the top of the house and deposit its load. (See Plate I, Frontispiece.) As the slanting sides of the house are often a network of loose sticks, the strength and energy required of a beaver in climbing in the erect position and carrying a heavy armful is amazing.

CONSTRUCTING DAMS.

In building dams beavers work from the upstream side. Sticks, leaves, grass, sods, and mud are laid across the stream and are added to until the flow is checked and the water begins to rise. Then, as it rises, sticks are pushed over the top and allowed to lie crisscross on the lower slope (Pl. IV, Fig. 1), bound in and securely held by mud and earth added to the top and upper slope, until high and strong enough to hold the water of the pond at the desired level and to be impervious to leaks and withstand the pressure of floods. The ends are extended as the water rises, and the final form and position of the dams are often the result of long tests of strength and endurance, experiments, failures, and changes; some of the larger dams are the work of many generations of beavers, and even where the builders were destroyed a century ago the dams still remain like solid breastworks below the old beaver meadows.

BUILDING HOUSES.

Beaver houses (Pl. IV, Fig. 2) are sometimes started around a burrow leading from deep water up through the edge of a marsh or the bank of a stream or pond; sometimes they rise from the bottom of the pond in open water 5 or 6 feet deep, sticks and mud being piled up until the surface is reached, when the structure is continued upward until a living room can be inclosed above the water level. A new house is very simple and not very tight, but before winter begins the walls must be thick and strong, if it is to be used for living quarters. Sticks, usually first peeled for food, are laid crisscross in all directions and weighted down with mud, sods, plant roots, and the wet material dug up from the bottom and banks of the pond.

A well-built house is a dense and well-fortified structure with walls often 2 or 3 feet thick, of heavily reinforced construction. When well frozen the walls are hard and impenetrable even to the bear and the wolverene, credited with being old-time enemies of the beaver. A well-built house usually extends 5 or 6 feet above the surface of the water and often as much below, and may be 20 or 30 feet wide at the water level. Anything larger is unusual, but I have seen some which I estimated to be 7 feet high and 40 feet wide.

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FIG. 1.—BEAVER DAM.

View from downstream, showing how sticks are pushed over the top to lie crisscross on the lower slope.

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FIG. 2.—BEAVER POND, HOUSE, AND WINTER FOOD CACHE.

This pond in the Adirondacks extends under and along both sides of the railroad tracks and at its present level is harmless. If raised a foot higher the roadbed would be endangered.

B23992

FIG. 1.—TIMBER KILLED BY BEAVERS.

Part of a large area of spruce, tamarack, and white pine killed by flooding. The water was raised about 2 feet and the ensuing loss of timber was estimated at between $5,000 and $6,000. Most of this loss could have been prevented by lowering the water at the dam 1 to 2 feet, as illustrated in text Figure 2 (p. 11), and at an expenditure for labor and materials of not more than $25.

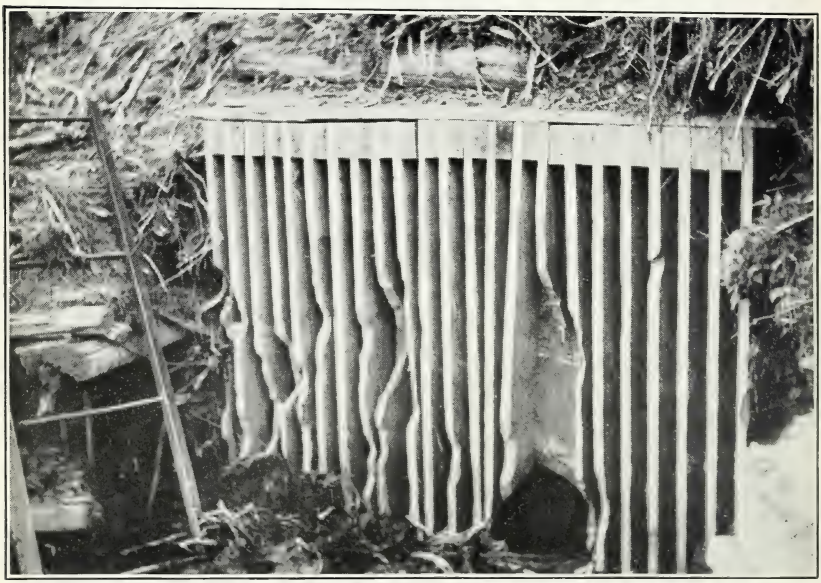

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FIG. 2.—RAILROAD CULVERT SCREEN CUT BY BEAVERS.

This culvert was repeatedly closed by the beavers and the water raised above the railroad. About a ton of sticks and mud had been taken out, and an iron ladder was kept there for use of the section crew, who removed the débris every few days.

The inner chamber is a simple cavity about 3 to 5 feet wide and 1½ to 3 feet high. It is partly cut out and shaped from the inside, all sticks being cut off flush with the surface on the inner wall, and if more room is needed the chamber is enlarged from within. A semidry bed of grass, twigs, leaves, or shredded wood is made 2 or 3 inches above the water level and close to the water hole. One and occasionally two large holes in the floor enter the water and come out under the bottom edges of the house 15 to 40 feet away, forming safe means of entrance and exit to and from the living room. If alarmed in the house the beavers dive into the water hole and may not show themselves at the surface within a quarter or half mile of the house, but usually a line of air bubbles escaping from their fur shows their course as they leave the vicinity of the house.

BREEDING.

Beavers apparently begin breeding when 1 year old, as one or two embryos are often found in females of 25 or 30 pounds, but some may not breed the first year. At 2 years old, when weighing 40 or 45 pounds, they may have 4 young and this seems to be the normal number for most beavers. There are a few records of 6 young and two or three of 8 embryos found in large, old females; but as the females have only two teats on each of the two large mammary glands, more than 4 young must be abnormal. So far as we can tell, the sexes are about evenly divided in numbers.

The young are born in May and a few late litters apparently in June. There seems to be no evidence of more than one litter in a season, and there is no more than time for one litter to grow up and get ready for winter between May and November. The time of mating and the period of gestation are not definitely known.

The mother beaver takes good care of the young and brings them tender plants and rootlets before they are old enough to leave the house. The father apparently remains away while the young are small, but in a large house in August I found 2 females, 1 male, and 6 good-sized young. Like all rodents, beavers are polygamous, and the fact that fights among the males take place indicates that the older ones strive for supremacy.

DAMAGE BY BEAVERS.

The trees cut by beavers for food[3] and building material are generally of little value, mainly aspens, cottonwoods, birches, and pin cherries, or such shrubby woods as willows, alders, bush maples, hazels, and smaller bushes. However, some choice trees are occasionally cut along lake or stream fronts, or in orchards situated

[3] For food habits, see pp. 6–7.

near the water, and complaints are at times registered of real damage and losses; but in many cases the trees could be protected with strips of woven wire at a cost of a few cents each and the beavers left unmolested.

The most serious damage which the beavers occasion by their dams results from the raising of water levels in streams, ponds, or lakes, which flood the low ground and kill great areas of valuable forest trees. In places in the Adirondacks hundreds of acres of valuable white pine, cedar, spruce, balsam, hemlock, and tamarack have been killed by one beaver dam, inflicting losses of many thousands of dollars on the landowners.

> In places beavers have increased to such numbers that their activities menace timber and other valuable property and make it necessary locally to control or destroy them. In most cases their control is not difficult.

Beavers sometimes dam the outlet of a lake and by raising the water level a foot or two kill all the trees around the shores, leaving a wide border of dead and dying timber that transforms beautiful and valuable camp or cottage sites or summer resorts into desolate, worthless wastes. (Pl. V, Fig. 1.) In a region which is popular and where camp and cottage sites are valued at several hundred or several thousand dollars each, the borders of a lake are often almost as valuable as city property, and such losses to landowners may reach a startling figure.

Other property losses are rarely so great, but are often very annoying. The flooding of roads and trails sometimes interferes with or suspends travel, delays lumbering or other business operations, or makes necessary tiresome detours and expensive repairs.

The flooding of railroad grades which cross low ground is sometimes serious, and has been known to interfere with the running of trains. Railroad culverts are frequently filled up by beavers in order that they may take advantage of the grades for their dams, and section crews are kept busy clearing out sticks and mud to keep the stream channels open. (Pl. V, Fig. 2.) There is sometimes actual danger to human life where the road bed is softened by high water and the track rendered unstable. Exercising those rare traits of animal intelligence, thrift, and industry which make beavers unique among our native mammals and of fascinating interest to

nature lovers brings them into disrepute when these activities run counter to the economy of civilization, and in such cases the animals are mercilessly denounced and many are killed. Ineffective methods of preventing their mischief cause much waste of time and unnecessary expense and only add to the unfavorable local sentiment against them.

BEAVER CONTROL.

Damage by beavers can be prevented by proper methods of control, based on a knowledge of the habits of the animals. Before any area is stocked with them the character of the country should be studied and suitable areas mapped, the beavers being restricted to these areas and trapping being allowed outside where the animals

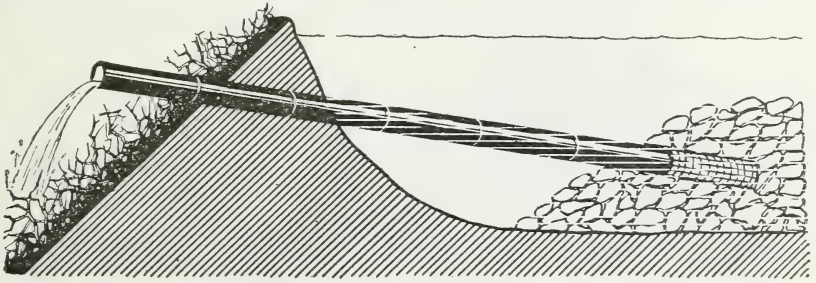


FIG. 2.—Pipe for lowering water in beaver pond. A 4 to 7 inch iron pipe with a cylinder of heavy wire mesh, inserted in the upstream end for a strainer, makes an effective drain for a beaver pond where it is necessary to lower the water only a foot or two. Larger pipes may be used or several small pipes laid together to carry a greater flow of water. Temporarily stovepipe can be used for such drainage.

would naturally do damage. It is useless to expect that beavers will remain and thrive where there is no suitable food or water, or in deep streams and lakes with high or rocky shores, or that they can be permitted to carry on their operations among small and closely cultivated farms, where they are sure to destroy property.

REGULATING THE WATER LEVEL OF BEAVER PONDS.

It is useless to tear out or dynamite beaver dams, as the beavers, if active, will replace them almost as fast as destroyed. A simple method of lowering the water and keeping it at any desired level above the beaver dam by means of a drainage pipe has proved, so far as tested, entirely successful. Many attempts have failed through imperfect methods, as the beavers will stop up the pipes or pull them out if possible, displaying much intelligence and energy in checking the water flow. The pipes must be securely laid and fastened down, with the intake thoroughly protected.

One or several pipes of sufficient size to carry the normal water flow should be laid through the dam with the outlet at the level at

which the water is to be held, the other end terminating in a wire strainer, reaching down into deep water and covered with stones or logs (Fig. 2). When the water has been lowered to the desired level the intake end of the pipe must still be well under water so that no marked current or water draft is perceptible at the surface. The pipes must also be securely held in place, so that they can not be pulled up, and the outlets must project a few feet beyond the lower face of the dam, in order that they may not be covered with mud.

In some cases it will be necessary to pipe the water some distance below the dam to prevent the beavers from building a second dam for retaining the water lost from the first. If the water is to be lowered to its original level a more elaborate system of drainage may be necessary, but in many cases lowering it 1 or 2 feet will save the timber

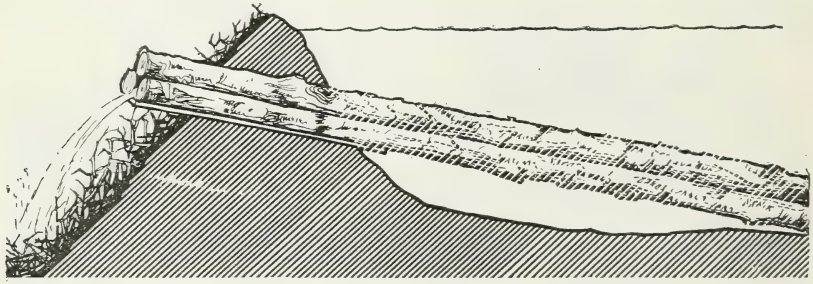


FIG. 3.—Three logs laid on a board or piece of sheet iron through the dam and sloping back into the pond, or more logs laid together to carry a greater water flow, in many places can be used to advantage to lower the level of the pond, in the same manner as that illustrated in Figure 2.

around the shores and still leave ample depth for the use of the beavers.

A very simple drain made of three or more straight hardwood logs laid on a board or a piece of sheet iron through the dam would serve in many cases as well as a pipe. The logs should be laid in the same manner as the pipe, two of them being slightly apart at the bottom and a third laid on top of them, their upper ends extending down into deep water (Fig. 3).

To discourage beavers from damming a stream, a blind drain of stones, logs, or tiling could be used, so that when a dam is started the water will still flow underneath.

FENCING BEAVERS.

One of the simplest and most important means of beaver control is fencing. While it may not be possible greatly to restrict the freedom of the animals on large streams or lakes, it is a simple matter to fence them on small streams or in lakes with small tributary streams. Advantage may be taken of their habit of not voluntarily

walking many rods back from the water, and of the fact that they will explore every possible stream and waterway, no matter how small, and even follow the bed of a tiny streamlet when dry in places in quest of new waters and a fresh food supply.

If a fence is constructed across small streams and out 15 or 20 rods on each side, the beavers will probably not go beyond it, although as yet this method has not been fully tested. By placing fences across strategic points in streams and valley bottoms, such as between high ridges or impassable banks, it will be possible in many cases to restrict the animals to certain areas, sometimes to a single drainage system or to a lake basin, so that generally, on large areas involving a complete stream system, fencing beavers should be far less expensive than fencing dry-land stock. On small areas of private property, however, it will usually be well to have the whole

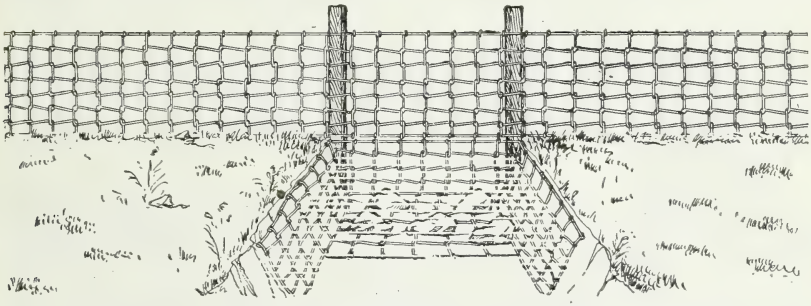


FIG. 4.—Beaver fence across creek. A beaver fence across a small stream should extend out 15 or 20 rods on each side and be securely laid on the bottom and along the sides of the banks of the stream. If desired, a passage-way or swing door in the bottom of the fence under water can be arranged to allow the beavers to pass in but not out of the inclosure.

area inclosed, and in some cases even to inclose the beavers with a fence which is proof against both dogs and men.

Types of beaver fence.—Ordinary poultry netting of 1-inch mesh will hold young beavers perfectly, but old beavers will cut it with their teeth and go through. The small young will climb up 2 or 3 feet on the inside of the wire and fall back; on one occasion a young one was known to climb to the top of a vertical 4-foot fence and tumble down outside.

To hold both young and old beavers, a 2-inch mesh fence of wires not smaller than No. 16 should be used. It should be 4 feet high, the top having a 6-inch overhang on the inside and the bottom being sunk 2 inches below the surface of the ground. I have never known an old beaver to climb over a fence or to dig under it unless there was a visible opening beneath it. Many of the woven-wire stock-fences would hold beavers perfectly, and if 5 feet high no overhang would be required.

Below the surface of the water, however, beavers will dig under or around a wire fence unless laid on the bottom or extended into the banks of the stream. It is necessary to use another width of fencing under water, laid out flat on the bottom and weighted down with stones or fastened with stakes, and to stretch securely staked side wings along the banks for several feet. (Fig. 4.) If the fence is to prevent the beavers passing either way the bottom and side wings should be used on both sides of the fence. If the beavers are to be permitted to pass in and not out of the inclosure, a V-shaped or funnel-formed opening or swinging door should be placed in the fence near the bottom.

The wings of the beaver fence should stand at right angles to the stream or converge to an apex at the banks, the ends being curved inward toward the stream to serve as an additional check. They should extend in most cases 15 or 20 rods beyond the flood and high-water points.

In times of flood or high water it will be necessary to guard against driftwood clogging the fence and possibly to build a secondary span of fence across the stream channel above to catch it.

TRAPPING FOR FUR.

In most parts of the country beavers are kept down to meager numbers by trapping, either legally or illegally, and in any section where they are doing damage they can be promptly removed by providing an open season for taking them. In fact, they are so easily trapped as to be one of the most difficult animals to protect. Except in large rivers and lakes, it is usually possible for experienced trappers to get all of them.

Trapping beavers for fur as practiced by amateurs is generally inefficient. Unless scarce and very shy, beavers are as easily caught as muskrats, but if the traps are not properly set and placed they will be found to contain only feet, the animal thus suffering needlessly and being lost to the trapper. If caught by a hind foot a beaver will sometimes still be found in the trap in the morning, but if caught by a front foot the leg bones are quickly broken and the foot twisted and torn off.

Weighted steel traps.—To obtain best results a double-spring No. 3 trap should be used with a stone weighing not less than 20 pounds securely wired to the bottom or outer spring. (Fig. 5.) The trap should be set 6 or 8 inches below the surface of the water where the beaver lands at the shore, or on the dam, and always near a depth of at least 2 or 3 feet of water. A 15 or 20 foot wire attached at one end to the trap chain and at the other to a strong stake driven below the surface of the water will allow the beaver to drag the trap and stone into deep water, from which it can not rise to the surface for air, and in a few minutes, probably not over 20 at most,

it will be drowned.[4] As trap and beaver are well hidden under the water, other beavers are not frightened away, the fur is uninjured, and there is no danger of the carcass being torn or eaten by predatory animals. It is the simplest, safest, and most merciful method thus far devised for taking beavers in steel traps.

Trap and slide pole.—Most trappers use a slide pole for fastening the trap and drowning the beaver—a long slender pole being thrust through the ring of the trap chain or a wire loop and slanted out into deep water and firmly bedded in the bottom. If properly arranged and slanted and in sufficient depth of water, the slide pole will act eventually to drown the beaver. Sometimes a wire or long chain is used instead of a pole, but this method is generally more difficult and less satisfactory than using the weighted trap.

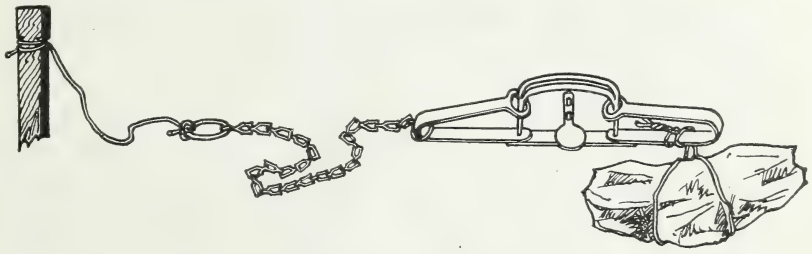


FIG. 5.—Weighted trap for drowning beaver. A stone weighing 20 to 30 pounds securely wired to the outer spring of the trap will sink and drown the beaver in a few minutes after it is caught if the trap is set where the animal can reach deep water.

Other methods.—Success in trapping depends largely on a knowledge of beaver habits. The animals will be driven away if the houses and bank dens are disturbed. Steel traps should not be set in water not deep enough to drown beavers. Other methods of trapping are mentioned in connection with capturing the animals alive for fur-farming purposes (p. 18).

PUBLIC AND PRIVATE TRAPPING.

Under the present system of game laws it is very difficult to protect beavers from illegal trapping, even on public lands and in public parks, and a radical change in sentiment toward the animals is desirable if they are to become valuable as public or private property. If beavers can not be kept under control by regulating water levels above their dams, or by fencing, trapping in season for fur, or by trapping alive and transplanting (see p. 23), they can always be checked and their ravages ended by allowing them to be trapped on private lands with the permission and under the direction of the landowner. This would stop all complaints and meet all objections to the introduction of beavers and would also encourage beaver farming.

[4] U. S. Deputy Game Warden Willett T. Gray, of Ashland, Wis., tells me that he has frequently timed trapped beavers that stayed under water for 15 minutes; in one case 17 minutes elapsed before an animal was forced to come to the surface for air.

Eventually, when public lands are sufficiently stocked, a limited amount of trapping on them should be allowed, preferably by public employees under rigid rules and inspection. The beavers should be taken alive and selected for fur and only the darkest and best left for breeding stock. In many cases the National and State forests, if fully stocked with the best beavers, should yield a valuable annual crop of high-grade fur.

NATURAL ENEMIES AND CHECKS.

Natural enemies of beavers have been bears, wolves, mountain lions, wolverenes, and probably coyotes and bobcats. Whether otters enter the houses and kill the young beavers has not been satisfactorily determined, but there is reason for believing they do. Dogs are likely to prove a serious menace if beaver farming becomes established in settled regions. Large snapping turtles might easily kill young beavers and should be exterminated from beaver ponds.

Diseases seem to be unknown among beavers in a wild state, but in zoological parks the animals have been known to die of tuberculosis, and it would seem a wise precaution to keep their surroundings in a sanitary condition. They are singularly free from insect parasites and their life in cold water seems to keep them in a generally healthy condition.

BEAVER FARMING.

That beavers are easily domesticated has been amply demonstrated, but raising them in captivity has not been carried far enough to gain all of the knowledge necessary for raising them successfully on a business basis. Under the very unfavorable conditions affecting animals on exhibition in zoological parks many litters of young beavers have been raised, notably in the Bronx Park at New York and in the National Zoological Park at Washington, so that the question whether they can be bred in captivity has already been determined.

Raising beavers for their fur under complete control or under semidomestication has not been thoroughly tested, but from a careful study of the habits and requirements of these interesting animals beaver farming in proper localities promises success if rightly managed. A beginning should be made with the darkest, handsomest, and most valuable stock and then the principles of selective breeding should be observed.

Young beavers are easily tamed and probably are the best stock to start with, but even adults have become thoroughly tamed and sufficiently gentle to be handled by those accustomed to animals. With plenty of clean water, good sleeping quarters, and a suitable food supply they can be kept in either large or small areas, and there seems no reason why they should not thrive and multiply in a satisfactory manner.

VALUE OF FUR.

The first question in regard to raising any animal for fur is whether the price its pelt will bring will be sufficient to pay the cost of raising and to yield a profit. Beaver fur has been generally considered low priced, and some of it is, but few animals vary more widely in value according to geographic areas. Skins from the lower Colorado River and Rio Grande are the palest, lightest furred, and lowest priced, the lowest recent quotations being $6 to $8 each, while the heavy-furred, dark-brown skins from Canada and Alaska in 1921 brought $20 to $25, and rare "black beavers" were quoted as high as $38. In northern Wisconsin choice skins have recently sold as high as $50 each. Obviously, if beaver farming is to be a success, only the choicest stock should be selected to start with, and this should be improved by selective breeding until the most beautiful fur of the highest grade and highest price is obtained. That $50 beaver skins can be produced in captivity seems probable, as in recent years the best beaver fur has not been legitimately in the market. Were actual values of beauty, warmth, and wear considered, choice black beaver should bring a much higher price. Under such conditions a reasonable profit would be assured.

SELECTING A LOCATION.

The longest, heaviest fur is produced in cold climates and the best beaver country is found in the Canadian and Hudsonian Zones, regions usually of relatively little agricultural value. In the United States these zones cover parts of the northern tier of States and extend farther south in parts of the colder mountain regions. The range of the aspen or poplar tree [5] is a good index to suitable beaver climate and conditions. (See map, Fig. 1, p. 3.) The aspen also furnishes the best beaver food and at present has relatively little commercial value. It grows naturally across the northern part of the continent from the barren grounds of Canada and Alaska south to the northern parts of the United States and, in the mountains, to northern Mexico. Wherever this tree is found, if other conditions are favorable, beaver farming might be successful.

Much of the best beaver country is in localities where, after the original timber has been lumbered off and the ground burned over,

[5] *Populus tremuloides* and varieties.

thickets of aspen and pin cherry have sprung up as second growth. Such land is generally considered almost worthless, but it might support a large beaver population and could be successfully handled on either a large or a small scale. A small fur farm, where detailed attention can be given to the animals, is likely to prove most successful at first and it can be extended when management practices are fully mastered.

> Should beaver farming on suitable areas prove a profitable enterprise, it would make remunerative considerable areas of now unproductive lands where such an industry would be valuable. The possibilities of success in beaver farming under proper conditions render this an attractive field for well-managed experiments.

A small natural pond or lake, or a small creek that could be fenced above and below to hold the beavers, would make a good site for a beaver farm, but if such sites are not to be had, a small artificial basin scraped out and filled with water from a spring, or even pumped from a well, would do for a beginning. The two essentials are water and food. A long section of stream valley, the headwaters basin of a stream system, or a lake or chain of lakes would afford ideal locations for extensive beaver farms.

FENCING FARMS.

After the location has been selected, an inclosure must be prepared that will hold the beavers and protect them from outside enemies. The specifications for fencing given under the heading Beaver Control (p. 11), will apply here equally well, but the more valuable the animals become the more difficult will it be to prevent losses from theft. In some localities only short sections of beaver-proof fencing will be required, but in others, a fence strong enough to exclude poachers and dogs will probably be necessary. Care and watchfulness will always be required, however, and the method of turning beavers loose to multiply without further effort or attention on the part of the owners will generally prove disappointing.

CAPTURING BEAVERS ALIVE.

Catching the young.—For domestication it is better to start with young beavers. They may be taken and raised at any time after

their eyes are open. Apparently they do not leave the house or bank den where born until a month or 6 weeks old, or some time in July. At that time they weigh 3 or 4 pounds and are easily caught in the water with a boat. They can be driven out of the house by shaking it or thrusting a slender stick into the nest cavity and rattling it around. In some places they can be scooped up in wire mesh dip nets as they come from the house through their under-water canals, but they are more likely to be first seen swimming with heads just above water not far from the house. In such cases, two people in a canoe, one in the stern to paddle and one in the bow to watch, can easily catch them. As they dive, the direction should be noted, the boat should be driven beyond the spot, and the water should be watched on all sides for the next appearance. Young beavers will not remain under water very long, rarely over two or three minutes, and after several swims under water they become tired and are readily approached and picked up by the tail as they come to the surface and pause for breath. They do not attempt to bite, and if carefully handled are gentle and quiet from the first.

It is usually possible to locate young beavers in a house by listening to their babylike cries, as they habitually cry a great deal, especially when hungry or disturbed. When old enough to come out regularly for food they can be seen before dark swimming about near their house or a little way out in the water. It is best not to disturb the houses unless young are known to be in them, but if great care is taken not to injure a house and to close securely any openings made, the young will not usually abandon it. If bank dens could be located, the young could probably be caught in them, but as there is no over-ground house to mark the spot and the under-water doorways are well hidden it is difficult to take them there.

Corral traps.—Both old and young beavers may be caught in corral traps at the edge of the water. A circular corral may be made of 2-inch woven-wire mesh, not lighter than No. 16 wire, at least 8 feet in diameter and 4 feet high, with a 3-foot door on the pond side. About seven posts or strong stakes will support the wire, which should be buried a few inches below the surface of the ground and at the top be bent in a 5-inch overhang on the inside. The door posts should be double if a drop door instead of a swinging door is used. Several kinds of swing doors can be devised, but the drop door is perhaps the simplest. It should be raised 2½ feet and hung from the top by a light, easily sprung trigger, with a string attached to a piece of green aspen for bait in the back of the corral or with a long thread to be pulled from a distance when the beavers are inside. (Fig. 6.)

The beavers can be baited first in the water in front of the corral, then closer, and soon inside. When the whole family or colony have formed the habit of coming into the corral the door can be set and made ready for their capture.

In most places green aspen bushes or branches make the best bait and will soon bring the beavers regularly for their meals. If these are not available the favorite local food can be used and will be preferred by the beavers to that which is only to be had by going back from the shore and cutting.

Pitfalls.—Adult beavers may be caught in pitfalls sunk across the regular trails where they drag their wood to the water (Pl. VI, Fig. 1). A hole 14 inches wide by 2 feet long should be dug across the

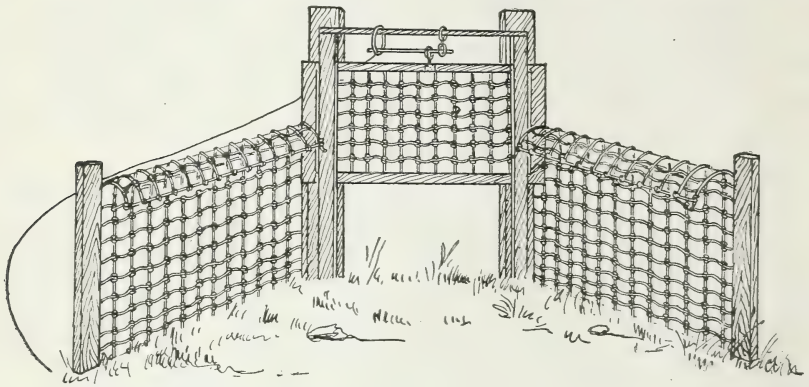
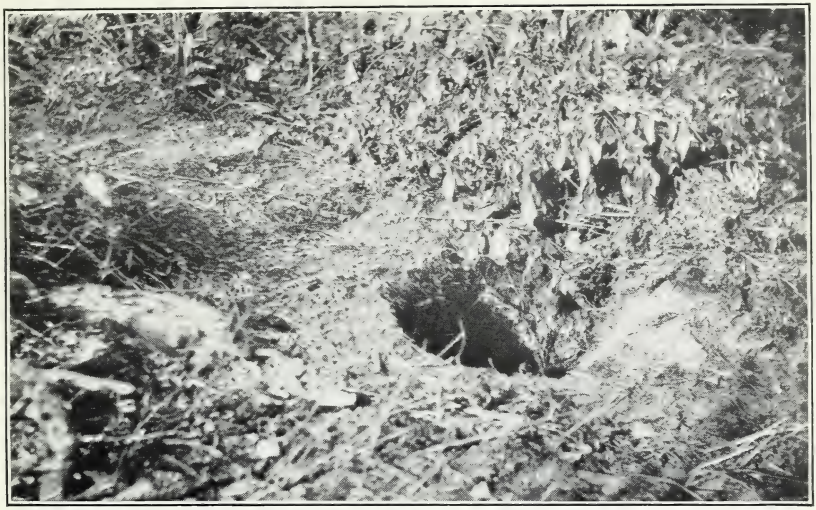


FIG. 6.—Corral for capturing beavers alive. Either drop, swing, or sliding doors can be arranged for closing the corral, but the drop door is the simplest where the beavers are to close it themselves from within. Three wire loops and a straight stick for a trigger provide a simple and effective means of springing the door.

trail 6 or 7 feet deep and the excavation enlarged below to a diameter of 3 or 4 feet. If a barrel or tin can is available it might be sunk in the ground in the trail for holding the beaver. If the pit is in sandy or mellow ground the bottom and the sides up 2 or 3 feet must be protected with boards or tin to keep the beaver from digging into the walls and filling up the pit in order to climb out. The excavated earth from the pit should be carried away in pails or sacks and the surface of the ground left in as natural and undisturbed a condition as possible. When all is completed, the tops of bushes should be laid in from both sides of the trail to near the middle of the mouth of the pit and the remainder covered with slender sticks, over which leaves and grass are scattered so that the hole does not show. The beavers may tumble in on the way to their feeding grounds, but are more likely to do so on the return trip, when occupied with carrying or dragging sticks to the water. Once caught in the pit they are easily dipped up in a wire basket or inclosed in a large sack slipped over their heads and bodies.



B23416

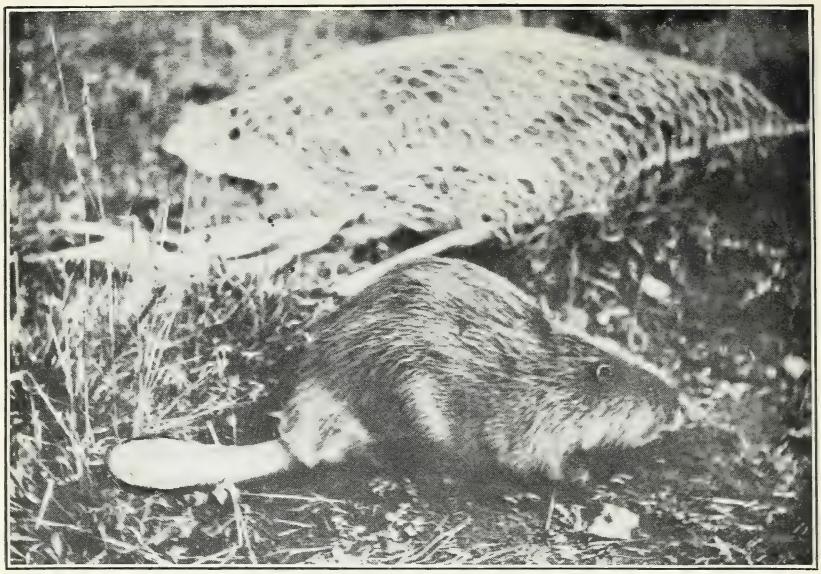
FIG. 1.—PITFALL FOR CATCHING BEAVERS.

This should be dug across a beaver trail, 5 to 6 feet deep, and lined with boards or tin around the sides at the bottom to keep the beavers from digging out. Three beavers were caught in three successive nights in the pit illustrated.

B22759

FIG. 2.—HEAVY TRAP FOR CATCHING BEAVERS ALIVE IN WATER.

This was used with success by field assistants of the Biological Survey, but is too heavy and expensive for general use. Weight 45 pounds; cost about $50. A trap of similar type is illustrated in text Figure 7 (p. 21). (Photograph by T. H. Scheffer.)



B23304

FIG. 1.—WIRE-MESH CARRYING BAG AND RECENT OCCUPANT.

The bag is easily made of poultry netting laced at the top with wire. A slender pole thrust through the mesh makes it possible for two people to carry it on their shoulders.

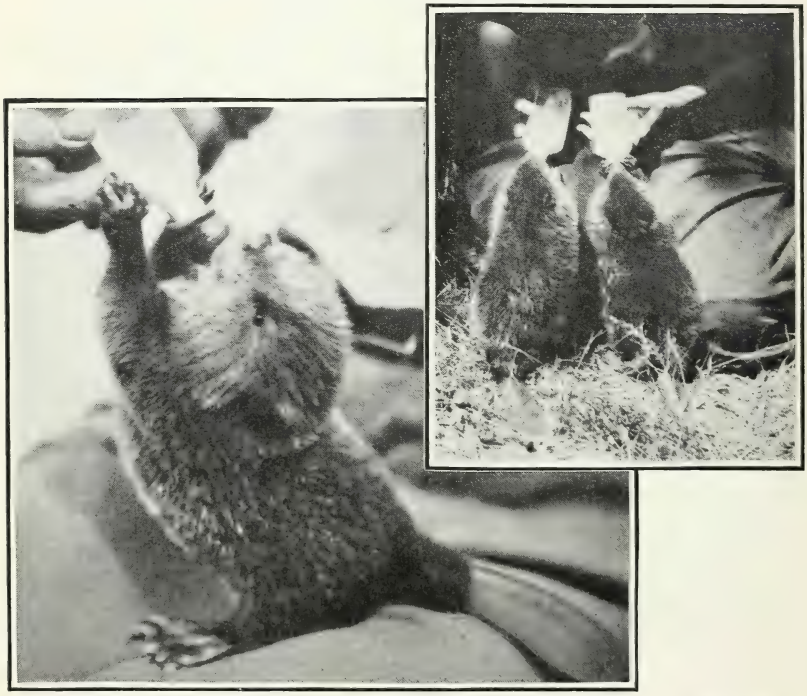


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FIG. 2.—"BOTTLE" BEAVERS GETTING THEIR BREAKFAST.

They are about 3 months old and weigh about 4 pounds each. The experiment with regular baby feeding bottles indicates the possibility of using more-natural foster "mothers," such as sheep or goats.

Steel traps.—The commonest method of capturing beavers alive is by use of No. 3 steel traps with the jaws well wrapped with cloth. The trap should be set under 8 inches of water just above a small break in the dam. The break need not be more than a foot wide and 2 or 3 inches below the water level, just enough to make a low roar that will be heard over the surface of the pond. One end of a piece of telephone wire, or similar wire, should be fastened to the trap chain and the other end to a bush or tall stake on which a cowbell is hung. The beaver will often come to repair the break before dark and may be caught and taken out of the trap early in the evening. It may sometimes be necessary for the trapper to sleep near the cowbell, as the beaver should be taken out of the trap before its

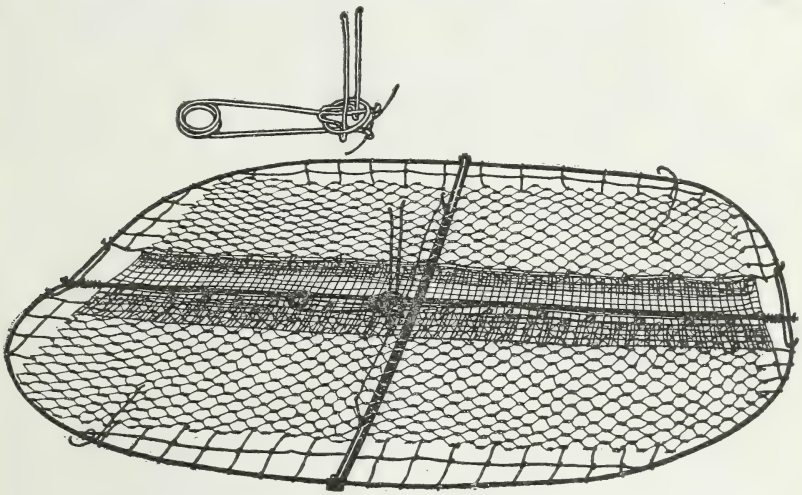

FIG. 7.—Light trap for catching beavers alive. This can be made at home or in any blacksmith shop at a cost for materials of about $5 or $6. Weight about 27 pounds.

foot is injured in struggling to escape. A wire basket should be at hand into which the beaver may be dropped before being released from the trap.

Cage traps.—A large trap on the general plan of a steel trap with wire or chain mesh sides to close over the beaver and catch it alive has been successfully used by the Canadian Park Service and by field assistants of the Biological Survey in the State of Washington (Pl. VI, Fig. 2). It is very effective in certain places where the animals pass through canals or along shallow streams, its main disadvantage being its bulk, weight, and cost.

A trap of somewhat different type seems preferable, especially for use in places where beavers pass along waterways. One can be made at home, or in a blacksmith shop, by any one of a mechanical turn, at a cost of $5 or $6 for materials. This trap when completed

weighs about 27 pounds. It may be constructed as follows (see Fig. 7):

Use two 5-foot strips of strap iron 1¼ inches wide by ¼ inch thick for base; two ⅜-inch steel rods, 8 feet long, for jaws; two 4-foot sections and two 6-foot sections of $\frac{3}{16}$-inch steel spring wire (No. 6) for coil springs; and 10 feet of 1-inch or 1½-inch mesh woven-wire poultry netting, 3 feet wide, of No. 16 wire, for the sides and bottom. For tools, a ⅜-inch drill, heavy pliers, hammer, wrench, and wire shears are necessary.

In the longitudinal base section of strap iron a hole should be drilled in the middle and two side by side in each end, and in the cross section a hole in the middle and one in each end. The ends of the longitudinal and cross sections should be bent up at right angles, 1½ inches above the base. These two strips should then be bolted together at right angles with a ⅜-inch bolt through the middle holes. By loosening this bolt the crossbar can be swung around under the trap to make it narrow for carrying. Bend the two rods for the trap jaws into an approximate semicircle with upturned ends an inch long. Slip the ends into the two holes in each end of the longitudinal base strip, leaving enough spring in the jaws to hold them in place.

Make coil springs of the two 4-foot pieces of spring steel wire by winding the middle of each closely six times around a 1½ inch pipe, and of the two 6-foot pieces, eight times around. This should be done while cold, or if heated, the wire must be very perfectly retempered. The straight ends of the wires can be heated and bent out 1½ inches at right angles and these right-angle sections curved sideways to clasp the trap jaws, with the 4-foot springs about 7 inches above the base and the 6-foot springs about 12 inches above the base. One of the long coil springs and then one of the short ones should be slipped over each end of the longitudinal base strip before the jaws are inserted in the end holes (only one of each pair of springs is shown in the illustration). After the jaws are in place the two ends of the short spring should be crossed with a strong tension and clasped around the jaws up about 7 inches from the base, then the long ones above them. The coil springs are light and give a quick, strong action to the jaws. A double-ended jump-trap spring of strap steel between the jaws and bolted down in the middle would have some advantages, but would add to the weight of the trap.

The wire mesh should be put on in five sections, one a foot wide the whole length of the bottom of the trap and wired securely to the longitudinal section; one on each side wired all around to the jaws and hinged at the lower edge to a 5-inch strip, with its lower edge again hinged to the piece on the bottom, so as to fold in as the trap is opened. This leaves the sides slightly full and convex, giving the closed trap a clamshell form with plenty of room inside for the beaver. The side walls should not be too rigid, but can be given ample play by being loosely hinged to the jaws and bottom strips. Wire rings or S links may be used for hinging. Clasping hooks on the edges of the jaws to lock them when the trap is sprung render it possible to use these light-rod jaws instead of heavier material

The trigger for springing the trap must stand upright in the center and spring by a slight pressure from any side as the animal swims against it. This can be accomplished in many ways, but the form shown in the diagram works perfectly and is easily made. The jaws must be held down on both sides by heavy wire catches, which, to give light pressure at the tips, may be 10 inches long, the tips held down by wire loops around the bottom cross-bar and the other end hinged in the holes at the ends of the cross-bar. The loops can be released simultaneously from both sides by crossed wires attached to a small double spring in the center wired to the longitudinal strip; this is released by a touch from any side on the upright trigger.

The trap should be set in the middle of a beaver canal or narrow water channel or in a pond, 10 or 12 inches below the surface of the water, with the upright trigger about 1 inch below the surface, where the beaver will swim against it, or an aspen twig may be attached to the trigger as bait.

Beavers may be taken out of the trap by the tails and dropped into a wire-mesh carrying bag (Pl. VII, Fig. 1), or a large gunny sack may be slipped over their heads and bodies while in the trap and used as a carrying sack. A slender pole can be run through the wire basket or through loops at the ends of the gunny sack, so that two people can carry the beaver between them on their shoulders.

TRANSPORTING BEAVERS.

Beavers are easily handled, and surplus stock in one locality may be shipped for long distances if properly crated. Adults will rarely eat anything if kept in close confinement and should be shipped at once to their destination or else kept in an inclosure large enough to have a house and a swimming pond well supplied with food.

For two adult beavers a box 3 by 4 feet and $1\frac{1}{2}$ feet high should be used, with partly open wire-mesh top and hand grips at the ends. One end or corner should be covered or inclosed for a dark retreat and nest. For food, bundles of aspen branches, or cottonwood, hazel, bush maple, or willow should be nailed to the sides and some branches, twigs, and leaves laid on the floor. For a three or four days' journey, two loaves of white bread should be fastened into the corners and a box containing 2 pounds of rolled oats nailed to the side or bottom of the box; a tin pan to hold a quart of water should be fastened in one corner, so that it can be filled from the top; no additional food need be supplied, but instructions should be given and written on the label, to keep the tin pan half full of water. Beavers are thirsty animals and suffer if they do not have plenty of water to drink. They show no inclination to gnaw out of the box when there is daylight above and will travel quietly and comfortably, except for fear and nervous excitement, which should so far as possible be avoided. The box should be marked *RUSH*, and no

delays allowed. At their destination the beavers should be placed at once in a pond or other swimming water and given a dark nest place. With this treatment their fear and nervousness will soon be removed and they will eat and function normally.

SELECTING BREEDING STOCK.

So far as is at present known, the darkest, richest-colored, and handsomest beaver fur is found native along the south shore of Lake Superior, in northern Michigan and Wisconsin.[7] In this region of heavy forest and deep snows the outer hairs of the animals are very dark brown and the underfur is almost black. When tanned and plucked the skins are very beautiful, and when made up into wearing apparel they almost equal sea otter in depth of fur and richness of color. They are decidedly superior to the Canadian and Alaskan skins, which have generally been considered the best and highest priced, but have only recently been quoted in the fur markets, as for many years the beavers of the region south of Lake Superior have been carefully protected and only taken illegally or for scientific specimens. They are now fairly abundant in this region, but an open season would greatly reduce their numbers. The disastrous effect of even a short open season where beavers have become tame has been demonstrated many times, and even the bungling methods of amateur trappers leave but a few crippled beavers to slowly restock the waters. If the beavers of the region south of Lake Superior are to be trapped it should certainly be as live animals for breeding stock. There are also occasional "black beavers" (melanistic individuals) throughout the north country, which always command high prices, and which may be utilized as breeding stock.

If a choice dark variety of beaver is bred successfully it would probably not be necessary to sell the skins for many years, as the demand for breeding stock should make the price for live animals much greater than their fur value. If a reasonably satisfactory maximum price could be established for live beavers the industry would thrive, but wildly speculative prices, such as black foxes have at times attained, would seriously handicap the enterprise. This danger is not imminent, however, as the source of supply is ample and there is no possibility of a cornered market for breeding stock.

There is always a distinct advantage in having fur raised under control, for superior prices can be obtained by marketing it when at its very prime, by selecting the animals at the right age and season and in the best condition for quality of fur. Relatively little

[7] The beaver inhabiting this area was described in 1913 as a new subspecies, the woods beaver (*Castor canadensis michiganensis*) from Tahquamenaw River, Mich. (Bailey, Vernon, Proc. Biol. Soc. Washington, vol. 26, p. 192, 1913).

perfectly prime wild fur is taken in the United States, even in the open season.

To improve the stock by selective breeding the choicest animals should be reserved for breeders and all inferior ones marketed for fur. For convenience in handling them, the corral traps (see p. 19) should be used. Suitable corrals or feeding yards can be kept in permanent use in order that the beavers may be inclosed at any time while feeding. The more accustomed they become to the presence and voices of people the less nervous and alarmed will they be when it is necessary to capture and handle them.

MARKING FOR SEX AND AGE.

The genital organs of beavers are internal, making it difficult to determine the sex. The male has a straight bone an inch to an inch and a half long in the penis, lying between the two large musk glands under the skin just in front of the anus. The female may be recognized by the absence of this character and by the two conspicuous teats on each of two mammary glands. The shape of tail and other external characters seem to have no relation to sex.

Every beaver should be carefully examined and in some conspicuous way marked for both sex and age. Branding on top of the tail with either a hot iron or chemicals would be permanent and conspicuous. Either recorded numbers or a sex mark and the year of birth might be used.

FEEDING AND CARE.

Young beavers can be raised on cow's milk and take eagerly to the nursing bottle (Pl. VII, Fig. 2). In the early fur-trade days they were occasionally nursed by the Indian women and raised as household pets. They could probably be nursed by such foster mothers as sheep, goats, and possibly dogs. Undiluted cow's milk is apparently too rich for them, so it should be skimmed or separated and boiled, and if it produces diarrhea should be given with lime water. When fresh milk can not be obtained powdered whole milk can be used. While little, beavers must be fed small quantities every four hours, night and day, to keep them quiet. If fed at longer intervals they are sure to overeat, with bad results. They should be encouraged to eat green vegetation and roots as early as possible. When about 2 months old they may be weaned and will live on green vegetation, leaves, twigs, and bark and roots, with rolled oats and bread as extras.

In fur farming one of the first considerations is an accessible supply of the proper food. There seems to be no overcrowding or overpopulation in beaver colonies where there is plenty available,

but after a few years, when the aspen and other choice foods are cut back for 8 or 10 rods from the shore, the tendency of beavers is to hunt for new quarters. When the supply becomes low on beaver farms, aspens or other desirable trees or bushes, when cut and hauled to the shores, provide an ample supply of food for summer and winter at little expense. By occasionally burning cut-over areas at the proper season a new supply of aspen would spring up. From information available it appears reasonable to estimate that a section (640 acres) of good aspen land ought to feed 1,000 beavers indefinitely if well managed.

Many other trees, bushes, and plants (see p. 6, under Tree Cutting for Food) are eaten by beavers and should be included in their food for the sake of variety. Coarse water grasses, rushes, sedges, and cat-tails are extensively eaten in summer, and waterlily rootlets, stems, and leaves are a choice food. Clover and alfalfa are eagerly eaten and could be raised on the slopes near the water as a supplemental food supply. Young beavers are especially fond of red-clover heads, lily-pads, and cowslips, and of the leaves and twigs of aspen, hazel, pin cherry, willow, mountain maple, striped maple, and various birches. As they grow older they eat more bark, and in winter their main food consists of bark, leaves, and twigs from the wood cached under water. Some roots and green vegetation may also be found along the shores and on the bottoms in winter. Both young and old beavers are fond of bread, rolled oats, and cracked corn, and possibly of other grains also. The effect of a variety of foods on the size and vigor of animals and on the color and quality of fur is a problem for future study.

Artificial houses should be provided where a new colony is started. A plank or log house 4 feet square with a hole in the bottom and a door in the back may be set over the edge of the pond with the bottom just touching the surface of the water, so the beavers can come up inside. A metal trap door opened and closed with an iron rod from the outside can be fitted over the water hole, so that the beavers can be shut in and examined at any time. If kept in this house overnight or a day before being released they will come back to it and use it regularly.

Under normal conditions beavers never deposit their feces except in the water, where they sink to the bottom or dissolve and disintegrate. I have never been able to find a trace of them in the houses, not even in those occupied by young, nor on the banks or shores. In captivity the beavers often hold their pellets as long as possible if no water is at hand, and unload them as soon as they get into water again. For this reason they should always have access to clean or running water.

HARVESTING THE CROP.

TAKING AND PREPARING SKINS.

Beaver skins should be taken only in midwinter, when the fur is prime, unless there should be a special demand for unplucked beaver fur, which is at its best before the outer guard hairs are full grown, while short and very glossy in September. It is then much like unplucked otter fur, and especially suitable for men's coats or collars.

The skins are usually taken off by a cut along the median line of the belly and stretched in circular form on a board or hoop. They must be carefully removed with a very sharp knife, as they do not peel off, but have to be cut close to the skin all the way. The skins should be stretched and dried in a cool dry place and kept cool until marketed, so that the oil will not soften and injure the leather.

UTILIZING THE MEAT.

After being skinned and dressed a beaver will weigh about half as much as before, that is, a fair-sized animal will dress about 25 pounds. This should include the tail and liver, which are especial delicacies. The tail is fatty tissue, very rich and palatable when cooked, and greatly relished by early trappers and explorers. The liver is large and almost as tender and sweet as that of a chicken or goose. The body meat has rather a gamy flavor, but if properly cared for and cooked is excellent and was generally preferred by trappers to any other game, even in the early days when buffalo, elk, and deer were abundant.

Great care must be taken in skinning a beaver not to get a trace of the musk on the meat, or it will be ruined. The musk and oil glands should be left on the skin until after it is removed, and especial care must be taken not to get any musk on the knife or hands. The musk glands have a commercial value. The carcass should be hung up by the head and kept clean. It might be possible to develop a good market for beaver meat if properly handled.

CONCLUSIONS.

Importance of beavers.—Beavers are of primary importance as fur bearers and conservators of water and soil; because of their unique habits they are also animals of general interest. In certain types of forest country, on farms, in irrigation ditches, and along trails, roads, and railroads, they are capable of doing serious damage; in such situations it becomes necessary either to remove them or to control them intelligently. Their control, however, is not difficult, and where they are doing damage on private lands they can

be quickly removed either by trapping alive for shipment or in the ordinary way for their fur.

Attitude toward beavers.—If beavers are to be treated as public property, it is as objectionable to place them on private land where they will destroy crops and timber as it would be to turn herds of hogs and cattle into cultivated grain fields to fatten on what they like best. A thorough knowledge of their nature and habits is necessary for their control, as also for their successful culture. In many States the game laws provide for a license, allowing the capture and raising of fur-bearing animals under necessary restrictions as a private industry, and in other States where there is no such provision the legislatures might well authorize the game commissions to provide such licenses and to take such other means as are necessary fully to control and regulate the beaver industry and protect private property.

Beaver farming.—The practicability of beaver farming has not been fully demonstrated, but from present knowledge it seems reasonable that the business of raising beavers for their fur will develop into a profitable branch of fur farming. Many problems must later be worked out, such as family and sex relations, extent of sociability and enmity, effects of large numbers on the health and increase of the stock, possible diseases, protection from natural enemies and poachers, and actual values and proper prices. However, the more immediate problems of capture, feeding, breeding, fencing, control, and shipping have been partially solved. To start beaver farming on a large scale at present would probably be unwise, but with a small beginning the enterprise seems to promise good returns and even great possibilities. When fully established it should greatly increase the value of a large area of north country and, by insuring a permanent supply of excellent fur, open up a new industry where greatly needed. Only such areas as are determined to be suitable should be stocked with beavers; the animals should not be introduced uncontrolled into places where their activities may menace irrigation or power ditches or important road or railroad grades. Sites selected for them should contain a suitable food supply and permanent water.

Utilizing forest areas.—Over a large part of our millions of acres of national forests beavers are capable of far more good than harm in conserving water and soil, weeding out timber of little value, making the silent places teem with interest, and yielding substantial returns in an annual fur harvest. With intelligent control to avoid local damage to valuable timber and other property and with wise restraint to prevent the dispersal of beavers over surrounding country, the usual complaints of damage can be eliminated. On some of the national forests beavers are already present and in places in-

creasing in numbers, but most of the animals are the western, pale, native varieties, worth much less than the choice, dark, prime fur bearers which might be introduced from other sections. Improving the system of stocking, management, and control will place beavers among our valuable forest products.

Cleared timberlands.—Another fertile field for beaver culture could be found in connection with projects for the reforestation with conifers of burned and cut-over timberlands. Many of these areas, cleared by ax or fire, and later covered with a second growth of aspen, willow, and pin cherry, are considered almost worthless. Over much of the northern border of the United States and still larger areas in Canada, such land is generally unsuited for agriculture and would not pay taxes until again covered with valuable forest timber, but would supply ideal food for beavers, and if stocked with these animals could be made to yield an income while the process of reforestation is going on. Not only could many limited areas of private land be thus reclaimed, instead of, as is so often the case, being relinquished as not worth their taxes, but State and Federal lands of this type could also be utilized for the double industry of fur and forest production.

Arctic waste lands.—There is a still more extensive field for beaver culture in the more northern areas of Canada and Alaska, beyond the commercially valuable forest timber, but where aspens and willows are an abundant part of the natural forest growth and where beavers were once so numerous as to yield annually millions of dollars worth of fur. If instead of the old policy of encouraging the extermination of animals by a wild scramble to get their skins, definite areas in these parts should be leased or sold to individuals or companies for raising beavers under control, as private property, this once valuable fur region would again become productive and develop related industries.

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